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SEWAGE-POLLUTED WATER SUPPLIES IN RELATION TO INFANT MORTALITY.

By Allan J. McLaughlin, Passed Assistant Surgeon, Public Health and Marine-Hospital Service.

The object of this bulletin is to invite attention to the excessive prevalence of "diarrhea and enteritis" of children in certain cities and towns, coincident with a polluted water supply. It will be apparent also that there is generally a parallelism between the curves for typhoid fever and enteritis in the winter months suggesting that water is a factor in the prevalence of both. Attention is invited to these conditions in the hope that cooperation between practicing physicians and local health officers will effect two things:

1. Investigation of deaths in the group classified as diarrhea and enteritis.
2. A wider use of municipal laboratories especially in the diagnosis of typhoid fever and dysentery.

These results can be attained only by the hearty cooperation of practicing physicians with the health officer. It is hoped that this cooperation will be effected, and out of this closer relation will come an earlier recognition and notification of typhoid fever and bacillary dysentery cases, and consequently more prompt and efficient control of the excreta of such patients.

An investigation of this group of diseases will probably reveal facts of the greatest value in relation to bacillary dysentery and other intestinal infections. No more promising field presents itself in the great problem of infant mortality than the study of the intestinal discharges of sick children. After giving due weight to the influence of climatic, racial, social, and economic conditions the so-called nonspecific factors, one must admit that these after all are only predisposing factors and that the greater number of deaths from enteritis under 2 years are probably caused by specific organisms, some well known and others of which we know little. It has been suggested that the vital resistance to disease is low in neglected young infants and that this vital resistance is lowered by syphilis and improper artificial feeding. The inference is that normal inhabitants of the human intestine, such as the bacillus coli, may attain sufficient virulence in such cases to cause severe diarrheas and sometimes death. There is little convincing proof of such an occurrence. Failure to find well-known organisms, such as the bacillus dysenteriæ, in summer diarrheas of children, must be ascribed in a portion of the failures to faulty technique, but in the great majority of cases the diagnosis is made as diarrhea or enteritis without any bacteriologic procedure.

These neglected, improperly fed babies may prove easier victims than their healthier brothers and sisters to typhoid fever or dysentery, but such an explanation is not necessary to account for the absence of classical symptoms of well-known diseases in children.

Typical symptoms of well-known diseases are recognized with difficulty in children and are frequently absent. Nervous manifestations are often predominant. Cases of Asiatic cholera in young children in the Philippines often present none of the classic symptoms, but instead are frequently diagnosed as convulsions, meningitis, or enteritis.

The mistaken diagnoses and in consequence the uncontrolled excreta of contagious intestinal disease are not justly attributable to an atypical clinical picture, but must be charged to the failure to establish the diagnosis by bacteriologic methods.

It is not unlikely that because of the atypical clinical picture in children, well-known diseases often do escape recognition and are responsible for many deaths now recorded as due to inanition, convulsions, marasmus, or some other indefinite diagnosis. Because of the common presence of diarrhea in sick infants a great many cases are diagnosed as diarrhea or enteritis without effort to determine the specific cause.

It is not intended to suggest that these infectious agents are purely water-borne germs. On the contrary, as we know in typhoid fever, Asiatic cholera, and bacillary dysentery, the causative agent may be transmitted in many other ways, and it is reasonable to suppose that other pathogenic organisms from the human intestines have a similar versatility in modes of transmission. Attention is invited to the rôle played by water merely as one phase of the problem. A thorough investigation in any city will bring out clearly the relative importance of dirty fingers, flies, and other factors in transmission.

Contact is probably one of the greatest factors in the transmission of diarrhea and enteritis. It is also the factor responsible for the persistence of the disease from year to year. In the winter the contact factor is reduced, but operates at a low rate which increases in the hot months. Flies and other factors augment the increased rate due to contact in the hot season. It is because of the contact factor that the breast-fed infant does not escape. The greater prevalence in bottle-fed babies is probably due to greater opportunities for infection. Young infants drink little water, and the effect of polluted water on infant mortality is probably most active through being mixed with milk. To polluted water also must be charged the infections in children resulting from contact with those who have contracted the disease through water.

THE RELATION OF SEWAGE-POLLUTED WATER SUPPLIES TO THE GENERAL DEATH RATE.

In the Journal of Infectious Diseases, August 24, 1910, Sedgwick and MacNutt describe what they call the Mills-Reincke phenomenon.[1] This is a marked decrease in the general death rate of cities independent of the reduction in typhoid-fever deaths following the substitution of a safe for a polluted public water supply. In the same article these writers accentuate the statement of Allen Hazen concerning the relation of a polluted water supply to the general death rate, which is known as Hazen's theorem. Hazen's statement was as follows:

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[1] Sedgwick and MacNutt: Journ. Infec. Dis., vol. 7, Aug. 24, 1910, pp. 489–564.

> Where one death from typhoid fever has been avoided by the use of better water, a certain number of deaths, probably two or three, from other cases have been avoided.

Sedgwick and MacNutt found abundant evidence of the occurrence of the Mills-Reincke phenomenon in studying the statistics of Hamburg, Lawrence, Lowell, Albany, and Binghamton. They also found that Hazen's "quantitative expression for the Mills-Reincke phenomenon" when applied to the cities which they studied, was sound and conservative. In their work Sedgwick and MacNutt brought out the close relation between polluted water and infant mortality. This fact had also been demonstrated by Reincke of Hamburg who laid especial stress on the diarrheal diseases of children. The general death rate is based upon the total number of deaths into the production of which a great many factors enter. Some of these factors are fairly constant; others are subject to great variation. Obviously it is more difficult to establish the relation between polluted water and the sum of factors, many of which have nothing to do with water, than to show the relation between water and diseases which are commonly water-borne. This difficulty seemed to be reduced by substituting infant mortality for the general mortality. This also is a vague, indefinite method, as infant mortality is made up of a great many different entities, and is subject to considerable fluctuation, due to the epidemic diseases of childhood, the connection of which with water is problematical or doubtful to say the least.

For these reasons the Mills-Reincke phenomenon could not be expected to be always present. Coincident with the substitution of a safe for a polluted water supply, an epidemic of whooping cough, measles, or scarlet fever might more than offset the reduction due to water. Or there might be an increase in pneumonia or diphtheria, which would prevent the general death rate from dropping.

The following charts (1, 2, 3, 4) show four cities which, after the installation of better water supplies, experienced marked reduction in the typhoid-fever rate.

TABLE NO. 1.—CITY OF PITTSBURGH, PA.

Deaths from certain diseases before and after filtration of the public water supply.

Causes of death.	Before filtration.			After filtration.		
	1905	1906	1907	1908	1909	1910
All causes	9,951	10,097	9,930	9,030	8,343	9,603
Under 1 year	2,432	2,554	2,405	2,195	1,930	2,259
Typhoid fever	574	728	645	255	130	149
Measles	215	122	68	247	44	177
Scarlet fever	191	81	46	84	70	119
Whooping cough	165	86	205	48	68	77
Diphtheria	128	178	130	98	82	136
Tuberculosis	897	876	765	762	729	625
Broncho-pneumonia	232	367	508	566	....	....
Lobar pneumonia	1,081	873	830	686	745	....
Diarrhea and enteritis	831	973	915	822	735	949

Summary.

Causes of death.	Average annual number of deaths, 3 years, 1905, 1906, 1907.	Average annual number of deaths, 3 years, 1908, 1909, 1910.	Average yearly decrease in deaths.
All causes	9,993	8,992	1,001
Under 1 year	2,695	2,128	467
Typhoid fever	649	178	471
Diarrhea, under 2 years	906	835	71
Tuberculosis	846	705	141

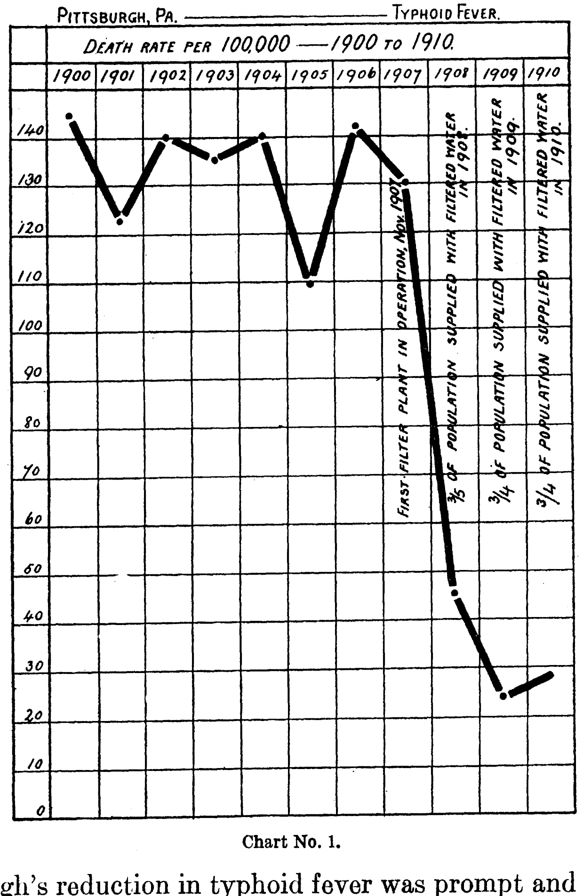

Chart No. 1.

Pittsburgh's reduction in typhoid fever was prompt and consistent. There has been an average of 1,000 actual deaths less each year since the installation of the filters. The average typhoid-fever reduction has been 471 deaths per year, so that for each death from typhoid fever avoided there have been 1.1 deaths less from all other causes. This is considerably less than Hazen's theorem suggests. There were 141 deaths less from tuberculosis, but the decline in tuberculosis has been gradual for some years.

TABLE No. 2.—CITY OF PHILADELPHIA, PA.

Deaths from certain diseases before and after filtration of the public water supply.

Causes of death.	Before filtration.			After filtration.		
	1905	1906	1907	1908	1909	1910
All causes	25,058	27,768	27,476	25,926	25,029	27,045
Under 1 year	5,263	6,010	5,522	5,386	4,992	5,334
Typhoid fever	724	1,078	890	529	341	272
Measles	94	404	99	266	231	164
Scarlet fever	67	74	120	208	147	152
Whooping cough	168	396	214	225	122	318
Diphtheria	466	566	494	489	511	479
Tuberculosis	3,365	3,742	3,717	3,490	3,496	3,191
Broncho-pneumonia	525	826	709	848	....	....
Lobar pneumonia	1,388	1,519	1,667	1,389	1,356	....
Diarrhea and enteritis, under 2 years	1,739	2,184	1,886	1,835	1,791	2,336

Summary.

Causes of death.	Average annual number of deaths, 1905, 1906, 1907.	Average annual number of deaths, 1908, 1909, 1910.	Average yearly decrease in deaths.
All causes	26,767	26,000	767
Typhoid fever	897	381	516
Diarrhea and enteritis, under 2 years	1,936	1,987	....

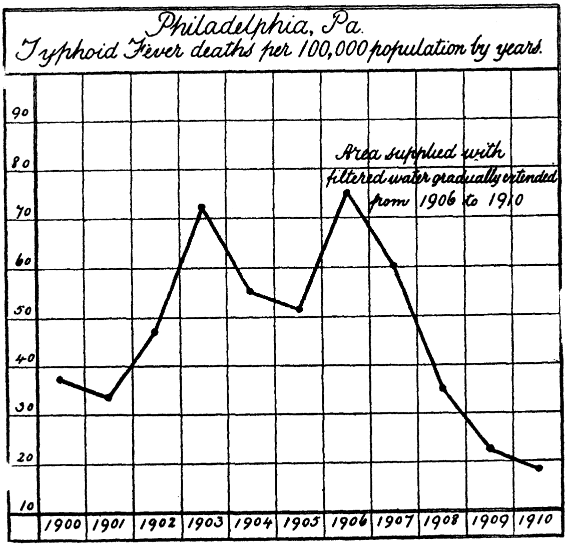

Chart No. 2.

Philadelphia does not conform to the quantitative expression of the Mills-Reincke phenomenon, taking an average of three years before and after the installation of the filters. Tuberculosis shows the same steady progressive fall both before and after filtration which was noted in Pittsburgh.

These two cities, Pittsburgh and Philadelphia, while they effected remarkable reductions in their typhoid fever rates, have the disadvantage of furnishing unfiltered polluted water to a portion of the population. Cincinnati and Columbus are better examples of the effect of improved water supplies, as their filtered-water systems cover the entire area of the city.

TABLE No. 3.—CITY OF CINCINNATI, OHIO.

Deaths from certain diseases before and after filtration of the public water supply.

Causes of death.	Before filtration.			After filtration.		
	1905	1906	1907	1908	1909	1910
All causes	6,609	7,179	6,423	6,450	5,938	6,319
Under 1 year	948	1,147	901	943	844	917
Typhoid fever	141	247	161	65	48	32
Measles	10	116	33	34	1	29
Scarlet fever	75	14	6	31	17	16
Whooping cough	57	19	13	29	22	30
Diphtheria	79	79	53	57	41	36
Tuberculosis	997	1,061	926	995	979	1,003
Broncho-pneumonia	140	194	169	162	....	....
Lobar pneumonia	441	389	373	404	362	....
Diarrhea and enteritis	245	366	265	301	282	328

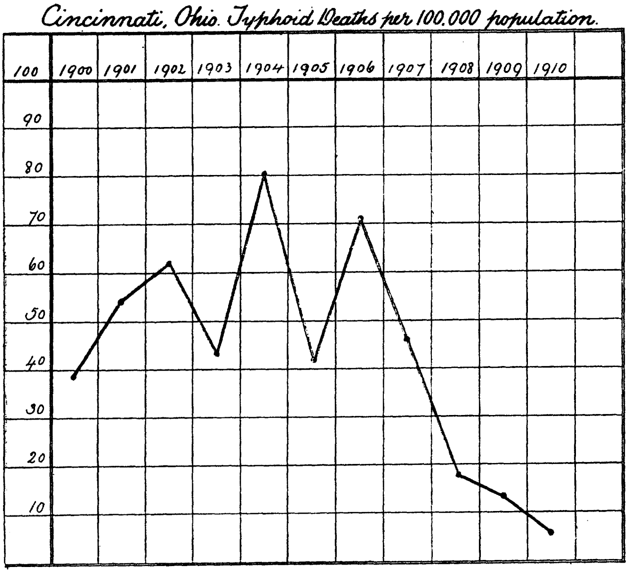

Chart No. 3.

Summary.

Causes of death.	Average annual number of deaths, 1905, 1906, 1907.	Average annual number of deaths, 1908, 1909, 1910.	Average yearly decrease in deaths.
All causes	6,737	6,235	502
Typhoid fever	183	48	135

TABLE No. 4.—CITY OF COLUMBUS, OHIO.

Deaths from certain diseases, before and after filtration of the water supply.

Causes of death.	Before filtration.			After filtration.		
	1905	1906	1907	1908	1909	1910
All causes	2,224	2,361	2,470	2,489	2,365	2,810
Under 1 year	277	364	329	336	316	397
Typhoid fever	121	54	57	168	33	33
Measles	....	7	1	5	16	43
Scarlet fever	3	8	2	1	2	6
Whooping cough	14	7	12	15	5	19
Diphtheria	35	20	15	14	9	21
Tuberculosis	328	352	346	331	318	337
Broncho-pneumonia	31	35	52	30	....	....
Lobar pneumonia	184	179	160	144	113	....
Diarrhea and enteritis	67	71	78	51	83	115

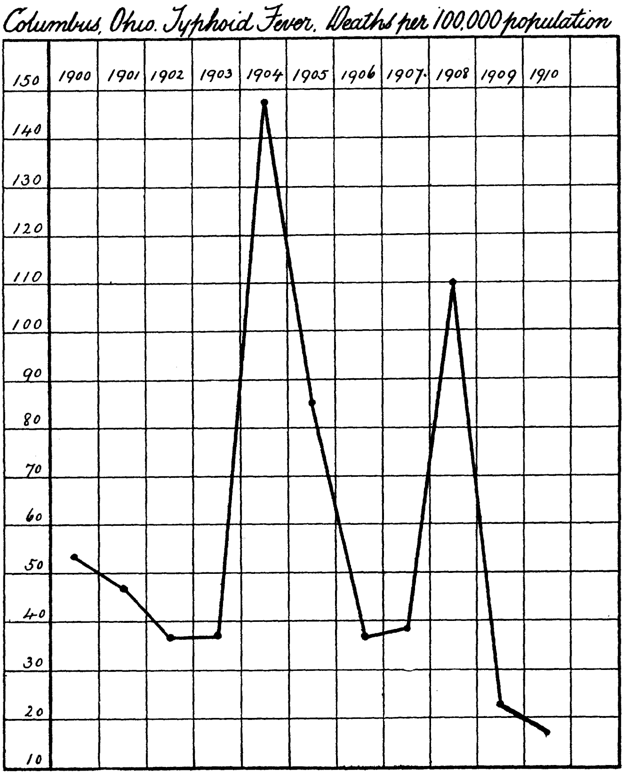

Chart No. 4.

Summary.

Causes of death.	Average annual number of deaths, two years, 1907, 1908.	Average annual number of deaths, 1909, 1910.	Average yearly decrease in deaths.
All causes	2,479	2,587	Increase.
Typhoid fever	225	66	159

Cincinnati seems to conform to Hazen's theorem, but Columbus does not, showing an increase in total deaths coincident with a marked typhoid decrease.

Many things may be cited which have a direct reducing influence on the general death rate—the use of diphtheria antitoxin, the campaign against tuberculosis, greater general knowledge of hygiene and the prevention of disease, the campaign for pure milk, and the educational work for the reduction of infant mortality. For these reasons if a gradual decline in the general death rate is noted coincident with or following an improvement in the public water supply, it can not be ascribed with any certainty to the improvement in the water.

If, however, there is a synchronous marked reduction below the average for a number of years, in certain diseases which are known to be water-borne, and especially if this reduction is effected in the winter and spring months, it is fair to assume that the improved water supply was the principal factor in this reduction.

Two distinct reasons are assigned for the reduction in the general mortality independently of typhoid fever which so often follows the installation of better water supplies. First, the increased vital resistance due to drinking a better water; second, exclusion of disease-producing organisms. It has been suggested that possibly a combination of these two is responsible. There is considerable evidence to show that the exclusion of disease-producing germs from the water is the principal factor in reducing the general mortality in so far as water is concerned.

In addition to the exclusion of the bacillus typhosus and the vibrio choleræ Asiaticæ, pure water means the exclusion of the causative organisms of bacillary dysentery, and probably other causative agents in diarrheal diseases of which we know little. The evidence that the so-called winter cholera is due to sewage-polluted water supplies may be considered incontrovertible. The exact nature of this alleged disease is unknown, but its existence and relation to polluted water have been shown conclusively at Erie, Pa., Escanaba, Lansing, and Mackinac Island, Mich., Michigan City, Ind., and other places.

There is no doubt that part of the reduction in the general death rate is due to a reduction in the deaths frequently certified to as "malaria," "typho-malarial fever," "typhoid pneumonia," and even "pneumonia" itself because of mistaken diagnosis. In many places there is very good reason to believe that there is a big reduction effected in fatal diarrhea of children really due to the bacillus typhosus. There is in some sections of the country a fixed idea that typhoid fever is a disease of adults and is rarely found in children. There is another common fallacy, that typhoid fever is a disease of summer and autumn only. It is due to these ideas that physicians are sometimes loath to diagnose typhoid fever in a child or to declare its existence in adults in the winter or spring. A health commissioner of one of the lake cities exhibited to the writer his record of cases reported in August, September, and October, pointing out the fact that there were nearly 10 cases reported for each death from typhoid fever. This was very creditable, but his records for January, February, March, and April showed that the cases reported scarcely exceeded the deaths. Very often the water supply is known to be polluted and the number of deaths from typhoid in the winter months shows that there is an undue prevalence of the disease in winter. The cases reported in relation to deaths would indicate perhaps a case mortality of 80 or 90 per cent. It is clear that in such instances the bulk of the nonfatal cases are not diagnosed as typhoid fever, and it is very probable that many fatal cases are certified as something else. In such cities it is not strange that the substitution of a safe for a polluted water supply effects a reduction not only in typhoid fever but in the general mortality as well.

DIARRHEA AND ENTERITIS UNDER 2 YEARS OF AGE IN THE UNITED STATES.

In the registration cities of the United States about 20 per cent of the total mortality occurs in infants under 1 year of age. The importance of infant mortality in relation to general death rate is at once apparent.

In considering infant mortality one of the greatest factors is the group of entities classified as diarrhea and enteritis. In the registration area in 1910 there were 154,373 deaths of children under 1 year, and 44,695 of these, or about 28 per cent, were ascribed to diarrhea and enteritis.

In the mortality statistics of the Bureau of the Census, under the name of diarrhea and enteritis, are grouped a number of different entities of diverse etiology. About 85 per cent of these deaths occur in children under two years of age. The fact that several distinct entities are included complicates the study of this group, and usually no attempt is made to separate these entities upon a specific etiologic basis. It is generally conceded, however, that certain nonspecific factors bear an etiologic relation to diarrhea and enteritis. At least the presence of one or more of these factors in marked degree is deemed sufficient to explain a high rate for diarrhea and enteritis in cities. These nonspecific etiologic factors may be divided into climatic, racial, social, and economic.

CLIMATIC INFLUENCES.

The influence of climate upon enteritis is conceded, but the manner in which this influence is exerted is still in doubt. The enteritis of children, including cholera infantum, is a summer disease, and if we exclude water or milk borne epidemics of specific enteritis, it should have a very low prevalence in the months from November to April. Naturally the southern cities, with their longer summer, on this ground alone are entitled to a higher rate for the hot-weather enteritis of children. Table No. 5 shows American cities with populations ranging from 100,000 to 300,000:

TABLE NO. 5.—*Cities having a population of from 100,000 to 300,000—Death rate per 100,000 from enteritis, all ages—Average for 8 years, 1901 to 1908.*

City.	Rate.	City.	Rate.
St. Joseph, Mo	37.5	Syracuse, N. Y	111.3
Omaha, Nebr	54.8	New Haven, Conn	116.6
St. Paul, Minn	57.5	Worcester, Mass	127.2
Minneapolis, Minn	58.5	Paterson, N. J	133.4
Columbus, Ohio	60.9	Providence, R. I	150.8
Louisville, Ky	63.9	Bridgeport, Conn	156.1
Kansas City, Mo	64.9	Nashville, Tenn	156.2
Dayton, Ohio	70.7	Atlanta, Ga	168
Denver, Colo	80.5	Jersey City, N. J	169.4
Indianapolis, Ind	84.7	Richmond, Va	176.3
Toledo, Ohio	86.6	Scranton, Pa	178.2
Rochester, N. Y	91.3	Lowell, Mass	274.1
Memphis, Tenn	101.1	Fall River, Mass	376.5
Grand Rapids, Mich	103.1		

It will be noted that the first 10 cities have rates below 90, and that every one of these is north of the thirty-eighth parallel of latitude and west of the eighty-third meridian.

It must not be inferred that the low rates in this area are entirely due to climatic influences. In most of these cities there is an absence of other factors, racial or economic, which play their part in the low rates.

On the other hand, favorable climatic conditions are not sufficient to prevent high rates in those northeastern cities, such as Fall River and Lowell, which possess the racial, social, or economic factors which make for high enteritis rates. In this class of cities (100,000 to 300,000) the eastern and southern cities, as shown above, have higher rates than those of the north and west, though probably for different reasons. The cities in the south have the climatic factor exaggerated greatly by the length of the summer and comparatively mild winters. The New England cities have high rates entirely independent of climate and depending in greatest measure upon certain economic conditions.

THE RACIAL FACTOR.

Racial characteristics are potent factors for good or ill in the prevention of infant mortality, although it is difficult to separate racial from economic influences. The pernicious effect of race is not because of the race itself but rather because the economic condition of the race is poor, and poverty and ignorance usually go hand in hand.

The southern cities suffer most from racial influences. The large negro population furnishes a very much higher rate per 100,000 for enteritis than the white population.

TABLE No. 6.—*Diarrhea and enteritis—Number of deaths per 100,000 population.*

Cities.	1906		1907		1908	
	White.	Colored.	White.	Colored.	White.	Colored.
Washington, D. C.	98.4	216.1	88	227.1	94	202.5
Baltimore	123.1	172.9	143.3	224.1	122	153.8
New Orleans	161.4	218.7	176.8	229.4	166.3	239.8

These higher rates are due in greatest measure to the insanitary conditions under which the people live.

SOCIAL AND ECONOMIC CONDITIONS.

This includes the well-known influence of the slums of our large cities on infant mortality. It also includes the high mortality among children of working mothers in mill and factory towns. These conditions are due primarily to poverty and ignorance, and are accentuated in the foreign quarters and among the negro population. The rate to be expected from slum conditions should be in direct proportion to the size of the city. In this complex problem this is not always the case, as some of the small cities have high rates due to other causes than slums. In general, however, all cities in America of over 300,000 population have high rates. St. Louis, Mo., is the only exception.

Table No. 7.—*Enteritis, all ages, death rate per 100,000—Average for eight years, 1901 to 1908—Cities with populations of over 300,000.*

Cities.	Rate.	Cities.	Rate.
Pittsburgh	205.1	Chicago	135.4
New Orleans	177.4	Newark	134.7
New York	162.6	Milwaukee	128.5
Buffalo	155.2	Detroit	122.9
Philadelphia	144.7	Cincinnati	117.9
Baltimore	140.7	Boston	115.4
Cleveland	136.6	St. Louis	88.1
Washington	135.6		

The high rates in these large cities are not surprising. New York because of its size should head the list, but New York has a very good water supply, and must give place to Pittsburgh, which previous to 1908 had a grossly polluted water supply, and the southern city of New Orleans, where the racial and climatic factors are accentuated. Buffalo's rate is altogether too high considering its population, but Buffalo also has suffered from a polluted water supply.

The appalling infant mortality in certain manufacturing cities and towns, especially those dependent on the steel and allied industries, is probably due to a combination of racial and economic factors. There is a very large percentage of foreigners in these cities, and probably a very high birth rate. The insanitary conditions are said to be very apparent. A special study of infant mortality in this class of industrial city would be necessary to determine accurately the real causes of this frightful infant mortality.

It is unfortunate that in America we are unable to secure accurate infant mortality rates because of lack of registration of births. The rates per 100,000 population are not an accurate index of the real infant mortality. Neither is the percentage of infant to total deaths a reliable guide. The true index of infant mortality is the death rate per 1,000 births.

For this reason the very high rates per 100,000 population in a city with a large foreign population and consequently high birth rate might seem much less significant if we had the ratio of deaths under 1 year to each 1,000 births.

In spite of these disadvantages the death rate per 100,000 tor diarrhea and enteritis is an index, if an imperfect one, of the infant mortality, and in most instances in this country must be employed for lack of a better criterion.

If we could eliminate the enteritis due to water we would have in these rates a very fair index of any city's sanitary condition. The city which is too small to have slums and which in spite of a good water supply has a very high enteritis rate has also in all probability insanitary conditions which are not essentially different from the slums of the large cities, at least in their effect upon infant mortality.

The enteritis rate for the smaller cities (less than 100,000) is even more accurate as an index of sanitary conditions, if we exclude waterborne enteritis. Table No. 8 shows the average rate for five years (1904–1908) for enteritis in cities with populations between 50,000 and 100,000. These may be divided conveniently into three classes: The first 15 have rates from 50 to 100; the second 15 have rates from 100 to 150; the third group of 13 have rates ranging from 164.7 in Schenectady, N. Y., to 342.3 in Charleston, S. C.

TABLE No. 8.—*Enteritis, all ages—Death rate per 100,000 in cities with a population from 50,000 to 100,000.*

Cities.	Rate.	Cities.	Rate.
Canton, Ohio	50.9	Johnstown, Pa	122.6
Lincoln, Nebr	56.9	South Bend, Ind	128.7
Saginaw, Mich	59.6	Utica, N. Y	133.7
Covington, Ky	65.0	Allentown, Pa	134.9
Harrisburg, Pa	65.2	Mobile, Ala	135.8
Fort Wayne, Ind	72.2	Pawtucket, R. I	137.1
Somerville, Mass	75.9	Hoboken, N. J	145.7
Portland, Me	77.4	Wilkes-Barre, Pa	147.0
Evansville, Ind	82.3	Schenectady, N. Y	164.7
Springfield, Mass	87.6	Youngstown, Ohio	186.5
Altoona, Pa	91.6	Elizabeth, N. J	191.7
Lynn, Mass	94.4	Manchester, N. H	195.8
Springfield, Ill	95.3	Holyoke, Mass	199.8
Terre Haute, Ind	96.2	Yonkers, N. Y	207.7
Hartford, Conn	97.0	Waterbury, Conn	217.9
Duluth, Minn	103.1	Bayonne, N. J	224.9
Wilmington, Del	106.3	Passaic, N. J	230.7
Troy, N. Y	112.4	Lawrence, Mass	257.1
Camden, N. J	113.9	New Bedford, Mass	257.6
Erie, Pa	116.6	San Antonio, Tex	268.3
Savannah, Ga	119.0	Charleston, S. C	342.3
Reading, Pa	121.8		

The first group of 15 with rates below 100 contains no city south of the thirty-eighth parallel of latitude. Some eastern cities are in this group. They are not "mill" towns, however, but cities of quite a different type, as Somerville, Mass., Hartford, Conn., and Harrisburg, Pa.

The second group has cities from all sections. The rates 100 to 150 are too high for cities of this size, and an intensive study of conditions will show the special reason or reasons in each case.

Duluth's rate of 103 is higher than one would expect. St. Paul and Minneapolis have rates below 60; Duluth's rate should be no higher. There is no negro factor to raise the rate, but there is quite a large foreign population. South Bend, like Duluth, has very much higher rates than cities in the surrounding territory. Wilmington, Del., Savannah, Ga., and Mobile, Ala., have rates no higher than might be expected with the large negro population. The excessive rates in group 3 are best explained by the insanitary conditions, high birth rate, maternal neglect, ignorance, and poverty of mill and factory towns. The last two cities are southern cities, and probably find the explanation of their high rates in climatic and racial influences.

During an investigation of cities in the drainage basin of the Great Lakes the writer was struck with the high rates for diarrhea and enteritis in some northern cities coincident with polluted water supplies and an absence of slums. A close relation also seemed to exist between the rates for enteritis and typhoid fever. The following table shows 12 New York cities. The first four have good water supplies, good sanitary conditions, and low rates for both typhoid and enteritis. The second four have good water supplies, low typhoid rate, bad sanitary conditions (mill and factory towns), and high enteritis rates. The last group of four have polluted water supplies, fair to good sanitary conditions, high typhoid-fever rates, and high enteritis rates.

TABLE No. 9.—*Cities in New York State.*

Cities.	Typhoid-fever death rate per 100,000, average, 10 years, 1900-1909.	Character of water supply.	Death rate, enteritis—average for 5 years, 1904-1908.	Remarks.
Rochester	13.7	Good	89.5	Sanitary conditions good.
Syracuse	14.8	.....do	105.5	
Albany	21.9	.....do	80.0	
Binghamton	20.9	.....do	104.7	
Utica	17.3	.....do	133.7	Mill and factory towns.
Schenectady	22.4	.....do	164.7	
Amsterdam	18.6	.....do	150.7	
Yonkers	9.5	.....do	207.7	
Cohoes	83.8	Polluted	170.9	Mill town.
Niagara Falls	129.1	.....do	173.2	Sanitary conditions exclusive of water, good.
Ogdensburg	148.5	.....do	175.0	
Buffalo	27.0	.....do	151.6	

A similar relation between typhoid and enteritis was found in Michigan, although coincidently high rates were not always associated with a polluted water supply.

The Michigan rates are for diarrhea and enteritis under 2 years instead of for all ages.

TABLE No. 10.—*Michigan cities, population from 12,000 to 50,000—Deaths per 100,000, average for 6 years, 1905–1910.*

Cities.	Typhoid fever.	Enteritis.	Water supply.
Escanaba	136	185	Polluted.
Sault Ste. Marie	52.3	134.6	Good.
Alpena	46.7	162.6	Polluted.
Ironwood	43.5	124.5	Doubtful.
Port Huron	42	78.6	Polluted.
Flint	43	63	Do.
Traverse City	42	53.5	Do.
Bay City	37.3	56.3	Do.
Lansing	33.3	56.6	Good.
Battle Creek	31.3	44	Doubtful.
Kalamazoo	29.5	59	Good.
Jackson	28.3	45.5	Do.
Muskegon	24.7	59.8	Doubtful.
Saginaw	24.6	42	Wells safe; river polluted.
Pontiac	24.5	44	Good.
Ann Arbor	22.1	18.6	Do.
Manistee	20.8	48	Do.

This table shows that in every instance, except Traverse City, a typhoid-fever rate above 40 was accompanied by an enteritis rate above 60. This is a high rate for Michigan cities, considering climatic, racial, and social economic conditions, as this rate is for enteritis under 2 years only. On the other hand, the cities with good water supplies had low rates for typhoid fever and enteritis except Sault Ste. Marie, which will be referred to later.

It is probable that contamination of food and drink with human feces is a very great factor in the mortality ascribed to diarrhea and enteritis. When there is gross pollution of a public water supply, as at Niagara Falls or Escanaba, this contamination may be transmitted by water, but from experience with typhoid fever and cholera it may be assumed that this fecal contamination is very often effected independently of the water supply by dirty fingers, flies, and in other ways. The enteritis so transmitted would necessarily have its great-

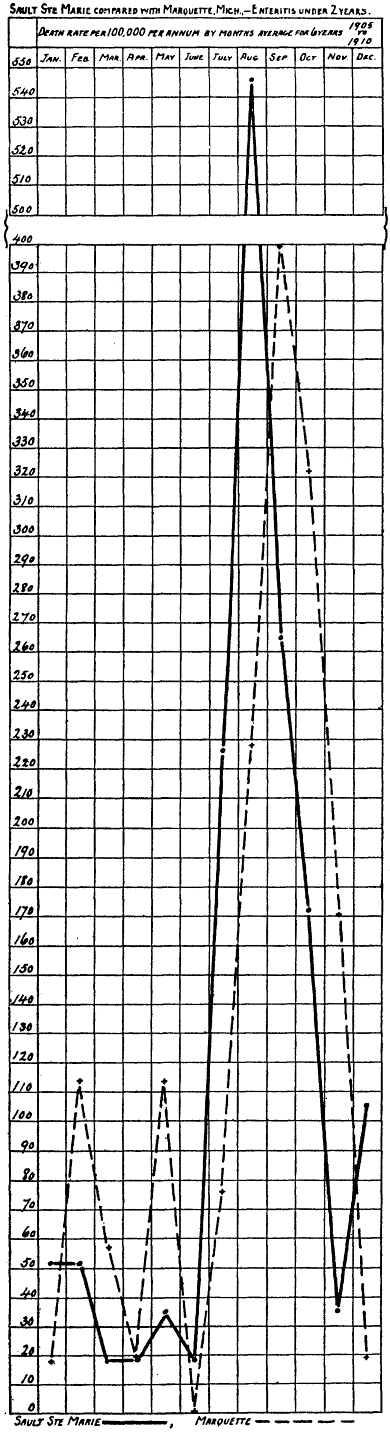
SAULT STE MARIE COMPARED WITH MARQUETTE, MICH.,—ENTERITIS UNDER 2 YEARS.
DEATH RATE PER 100,000 PER ANNUM BY MONTHS AVERAGE FOR 6 YEARS 1905 TO 1910
JAN.
FEB
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEP.
OCT
NOV.
DEC.
550
540
530
520
510
500
400
390
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
SAULT STE MARIE ———,
MARQUETTE — — — — —

Chart No. 5.

est prevalence in the hot months and its rate would be high in direct proportion to the insanitary surrounding of the victims.

Sault Ste. Marie has a very high rate for enteritis. The public water supply must be classed as good. As a consequence it is not strange that the winter and spring rate in Sault Ste. Marie is much lower than that of Marquette with its polluted water supply. Chart No. 5 shows the difference in the seasonal prevalence.

Ishpeming has a low typhoid-fever rate and a water supply which is probably safe. It has a very high death rate for diarrhea and enteritis. This is probably due to the insanitary conditions under which the foreign population lives. The greatest seasonal prevalence is in the summer and autumn months with practically no deaths in the winter and spring months. Chart No. 6 shows the seasonal prevalence in Ishpeming.

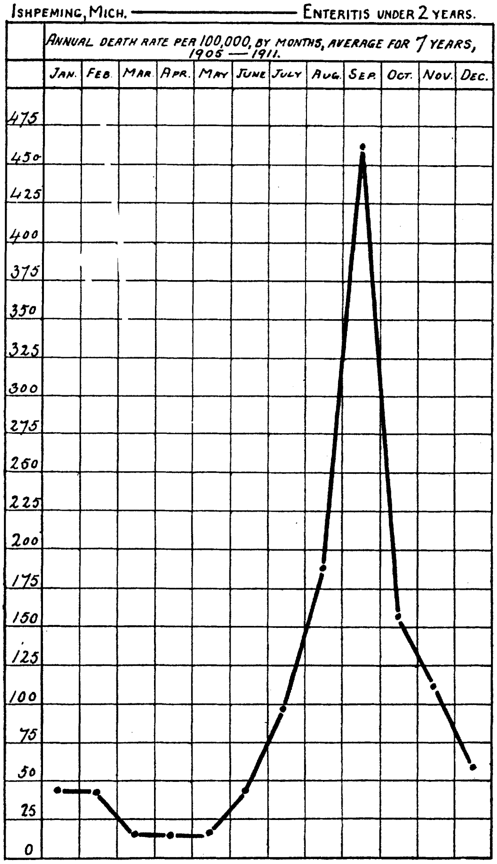

Chart No. 6.

The factors operating in the summer months—flies, fingers, careless disposal of excreta, bad personal hygiene—are scarcely separable from the other factors associated with poverty and ignorance, including maternal neglect.

From a study of statistics and conditions in cities and towns in the drainage basin of the Great Lakes, the writer is inclined to believe that the reduction in the general death rate coincident with and following improvement in the water supply independent of typhoid reduction, is largely due to the reduction effected in the group of entities classified as diarrhea and enteritis.

THE RELATION OF POLLUTED WATER SUPPLIES TO THE SO-CALLED DIARRHEA AND ENTERITIS OF CHILDREN.

In attempting to estimate the importance of water in the prevalence of diarrhea and enteritis it will be necessary to consider the deaths by months. This disease, or group of diseases, if not water borne, has a relatively low prevalence in the winter and spring months. This point is well illustrated by the seasonal prevalence in cities with good water supplies. In dealing with seasonal prevalence the climatic factor is very prominent. For this reason it would be manifestly unfair to compare southern with northern cities. In the following consideration of enteritis the writer will confine himself to cities north of the thirty-ninth parallel and east of the Mississippi River.

In cities with good public water supplies the seasonal prevalence of the diarrhea and enteritis of children is uniform, and Chart No. 7 illustrates this seasonal prevalence in the city of New York. If the public water supply is not a factor, the greatest number of deaths should occur in July and August.

TABLE No. 11.—*Cities having a population of over 250,000 and enteritis rates above 100 per 100,000.*

Cities.	Enteritis under 2 years—annual death rate per 100,000.			Ratio of summer to winter enteritis.	Character of water supply.
	Entire year, 1910.	Summer, June to November, 1910.	Winter, December to May, 1910.		
Jersey City, N. J	146	259	37	7 to 1	Safe.
Detroit, Mich	123	212	34	6.2 to 1	Doubtful; exposed to pollution.
Boston, Mass	100	172	32	5.3 to 1	Good.
Newark, N. J	113	189	42	4.4 to 1	Do.
New York, N. Y	123	198	46	4.3 to 1	Do.
Buffalo, N. Y	132	209	53	3.9 to 1	Polluted at times.
Pittsburgh, Pa	179	277	77	3.6 to 1	One-fourth of the population uses unfiltered water.
Cleveland, Ohio	169	261	73	3.5 to 1	Polluted at times.
Philadelphia, Pa	150	241	70	3.4 to 1	A portion of the city uses unfiltered polluted water.
Chicago, Ill	159	248	102	2.4 to 1	Polluted.
Milwaukee, Wis	117	147	89	1.6 to 1	Do.

A study of the statistics of cities with good water supplies and fairly high enteritis rates brings out an interesting phenomenon. The mean annual enteritis death rate per 100,000 for the months of June, July, August, September, October, and November bears a definite relation to the rate for December, January, February, March, April, and May. This will be referred to as the ratio between the summer and winter enteritis rates. If very low annual rates for enteritis prevail, this relation is disturbed; but if the rates are above the normal, even if very excessive, as in some mill towns, the ratio is preserved, provided the public water supply is not polluted.

In large cities with enteritis rate per 100,000 of more than 100 for the entire year the ratio of summer to winter enteritis should be not less than 4 to 1, provided the public water supply is not grossly polluted.

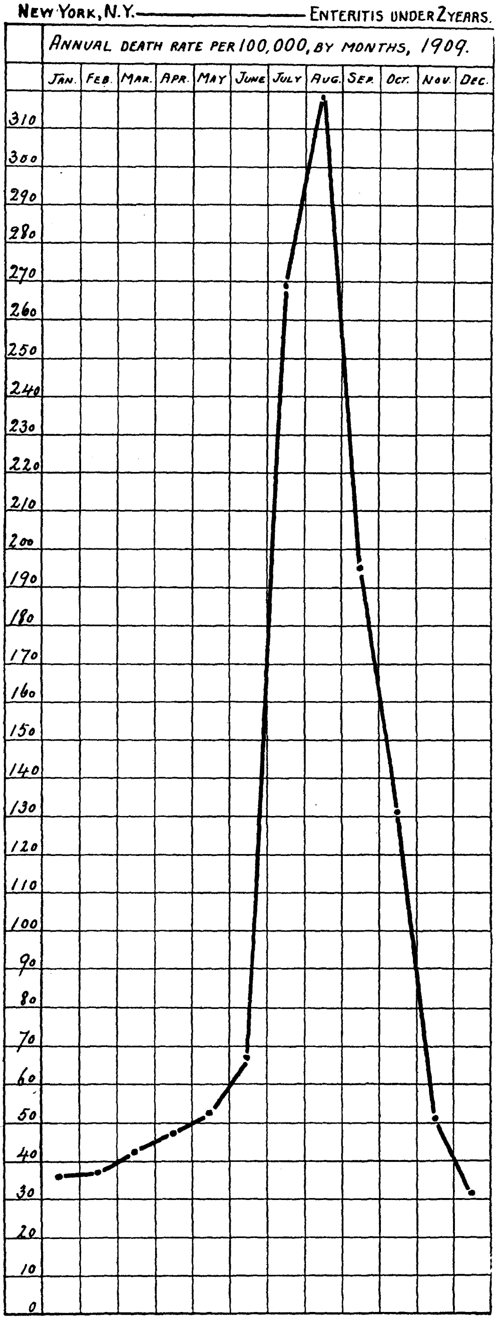
New York, N.Y.
Enteritis under 2 years.
Annual death rate per 100,000, by months, 1909.
Jan.
Feb.
Mar.
Apr.
May
June
July
Aug.
Sep.
Oct.
Nov.
Dec.
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0

Chart No. 7.

TABLE No. 12.—*Cities having populations from 100,000 to 250,000 and enteritis rates above 90 per 100,000.*

Cities.	Death rate per 100,000; enteritis under 2 years, 1910.	Ratio of summer to winter enteritis.	Cities.	Death rate per 100,000; enteritis under 2 years, 1910.	Ratio of summer to winter enteritis.
Paterson, N. J.	117.3	8.8 to 1	Cambridge, Mass.	94.2	6.0 to 1
Worcester, Mass.	134.3	7.9 to 1	Rochester, N. Y.	99.7	5.4 to 1
Fall River, Mass.	373.8	7.3 to 1	Grand Rapids, Mich.	95.4	5.7 to 1
Scranton, Pa.	230.8	7.3 to 1	Bridgeport, Conn.	123.7	4.7 to 1
Lowell, Mass.	252.0	6.9 to 1	Syracuse, N. Y.	122.4	3.7 to 1
Dayton, Ohio	91.6	6.6 to 1			

TABLE No. 13.—*Cities in the State of New York.*

Cities.	Enteritis under 2 years, death rate per 100,000, average for 3 years, 1908-1910.		Ratio of summer to winter diarrhea.	Character of water supply.
	Summer, June to November.	Winter, December to May.		
Amsterdam	342	27	12.5 to 1	Good.
Utica	254	29	8.7 to 1	Do.
Troy	169	21	8.0 to 1	Do.
Binghamton	162	21	7.7 to 1	Safe.
Schenectady	229	34	6.7 to 1	Good.
Syracuse	207	31	6.6 to 1	Do.
Rochester	152	26	5.8 to 1	Do.
Albany	95	19	5.0 to 1	Do.
New York	208	44	4.7 to 1	Do.
Yonkers	337	74	4.5 to 1	Do.
Buffalo	106	29	3.6 to 1	Polluted.
Niagara Falls	191	93	2.0 to 1	Grossly polluted.
Cohoes	221	133	1.6 to 1	Do.

It is clear also that no deduction regarding the part played by water can be drawn safely from high rates in winter months alone unless these rates are more than one-fourth of the rates for the summer months. For example, high rates in Yonkers or Amsterdam in December, January, February, March, April, and May do not necessarily indicate polluted water, in view of the fact that the summer rates are very high and more than four times those of the winter months.

High rates in the winter months with relatively low rates in the summer months, as in Cohoes and Niagara Falls, leave no escape from the conviction that the polluted water supply is a big factor in this mortality. In the territory north of the thirty-eighth parallel and east of the Rocky Mountains there is no factor in the transmission of intestinal diseases except water, which operates consistently with greatest intensity from December to May.

The possibility of milk causing outbreaks of intestinal diseases in winter or spring months is admitted, but milk is unlikely to operate with greater intensity in winter consistently for a number of years.

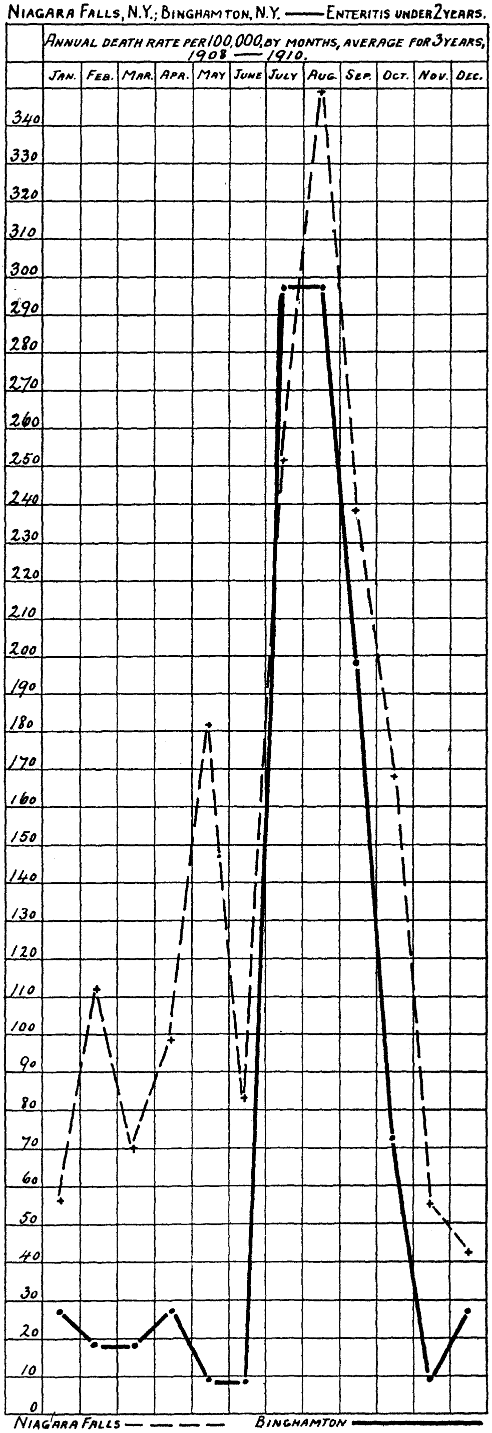
NIAGARA FALLS, N.Y.; BINGHAMTON, N.Y. —— ENTERITIS UNDER 2 YEARS.
ANNUAL DEATH RATE PER 100,000, BY MONTHS, AVERAGE FOR 3 YEARS, 1908 —— 1910.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEP.
OCT.
NOV.
DEC.
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
NIAGARA FALLS — — — —
BINGHAMTON ——————

Chart No. 8.

TABLE No. 14.—*Cities in the State of Michigan.*

Cities.	Enteritis under two years, death rate per 100,000, average for six years, 1905 to 1910.		Ratio of summer to winter enteritis.	Character of water supply.
	Summer—June to November.	Winter—December to May.		
Battle Creek	77	9	8.5 to 1	Fair.
Jackson	89	11	8 to 1	Pure.
Flint	111	15	7.4 to 1	Wells pure; river polluted.
Lansing	96	14	6.8 to 1	Good.
Sault Ste. Marie	278	43	6.4 to 1	Do.
Bay City	101	16	6.3 to 1	Doubtful.
Grand Rapids	140	27.2	5.1 to 1	Do.
Port Huron	135	33	4 to 1	Polluted.
Marquette	199	57	3.4 to 1	Do.
Alpena	257	91	2.8 to 1	Do.
Escanaba	209	168	1.2 to 1	Grossly polluted.

In Michigan it is probable that the summer enteritis rate should be more than four times the winter rate. The three cities which fall below the ratio of 4 to 1 all have polluted water supplies, and this is also true of Grand Rapids and Port Huron, the next on the list.

Chart No. 8 shows the seasonal prevalence in Niagara Falls, compared with Binghamton, N. Y. Niagara Falls has a grossly polluted water supply, while Binghamton has a safe one.

Chart No. 9 shows Cohoes compared with Amsterdam. Cohoes has a grossly polluted water supply, while Amsterdam's supply is rated as good. Amsterdam has a very much higher rate in July, August, and September than Cohoes, and if no water factor entered into the problem should have the higher rate in the winter and spring months. The high rate in Cohoes for December, January, and February is very striking.

Chart No. 10 shows Marquette, Mich., compared with the normal curve for the State of Michigan. The sharp rises in February and May are noticeable. Marquette has had a very high typhoid rate and the water supply has been grossly polluted at times.

Chart No. 11 shows Buffalo, N. Y., compared with Washington, D. C. Buffalo has a polluted water supply. Washington has a safe water supply. Buffalo has a lower rate than Washington in the summer and should have a lower winter rate if water was not a factor. The high rates in March, April, and May in Buffalo are well shown on the chart.

Chart No. 12 compares Chicago and New York. The Chicago rates are abnormally high from January to June and a distinct peak is noticeable in March.

Chart No. 13 shows Milwaukee compared with Jersey City. Milwaukee has a sewage-polluted water supply while Jersey City's supply is safe. The abnormal peak in March and the very high rates in March and April are very striking and suggestive. Jersey City, with its very high rate in July, August, and September, would have a higher rate than Milwaukee during the winter months if the winter rates depended upon other factors than water.

Chart 14 shows Cleveland compared with Jersey City. Cleveland has had a polluted water supply in the winter and spring months.

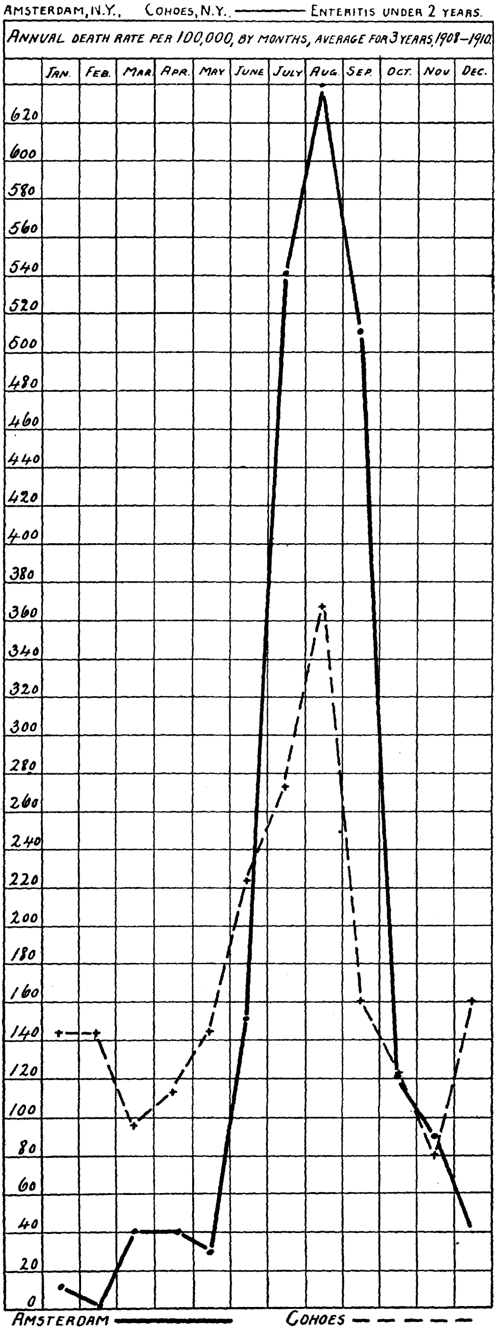
AMSTERDAM, N.Y., COHOES, N.Y., ——— ENTERITIS UNDER 2 YEARS.
ANNUAL DEATH RATE PER 100,000, BY MONTHS, AVERAGE FOR 3 YEARS, 1908–1910.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEP.
OCT.
NOV.
DEC.
620
600
580
560
540
520
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
AMSTERDAM ———
COHOES — — — — —

Chart No. 9.

The high rates in the first half of the year and the sharp rise in March are remarkable. Compare this March rise with that of Chicago and Milwaukee in the same months. (Chart No. 15.) The similarity is striking, in view of the similarity in the character of their water supplies.

Chart 16 shows the average rate for six years in the city of Alpena compared with the rate for the entire State of Michigan. Not only is the annual rate for Alpena excessive, but the very high rates in the first half of the year and especially the peak for May are noticeable features of this chart. Alpena uses an unfiltered and polluted water supply.

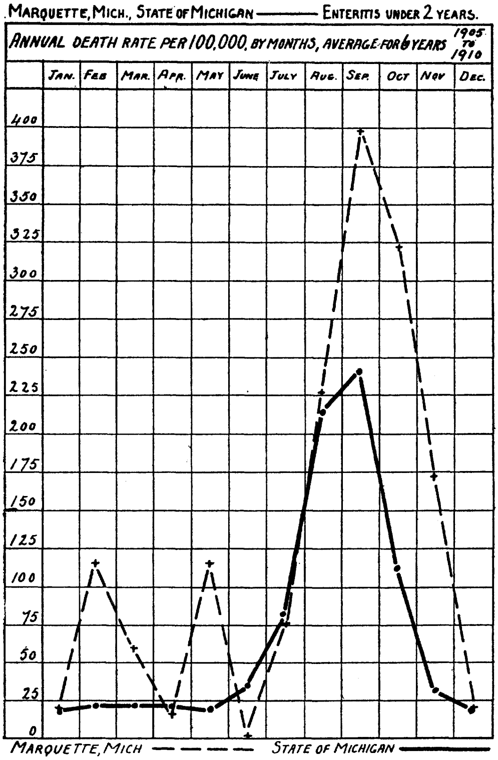

Chart No. 10.

Chart 17 shows the average rate for diarrhea and enteritis in Escanaba, Mich., for six years by months. The chart speaks for itself. Escanaba has been notorious for its polluted water supply and outbreaks of "winter cholera" and typhoid fever.

In 1910 a mechanical filter plant was in operation in Escanaba. Its operation was not entirely satisfactory, but it seemed to have a marked effect upon the typhoid-fever rate and winter enteritis of children in the winter and spring of 1910.

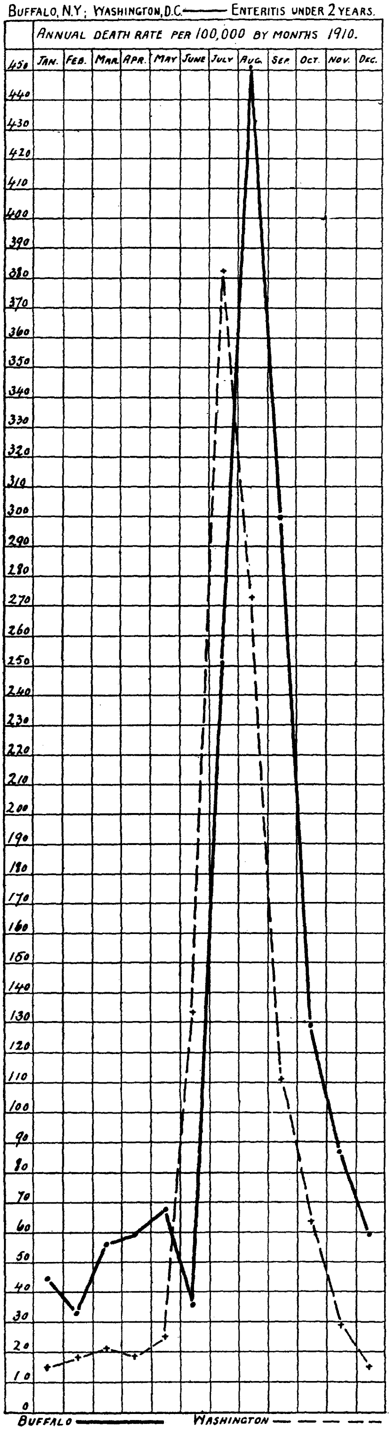

Chart No. 11.

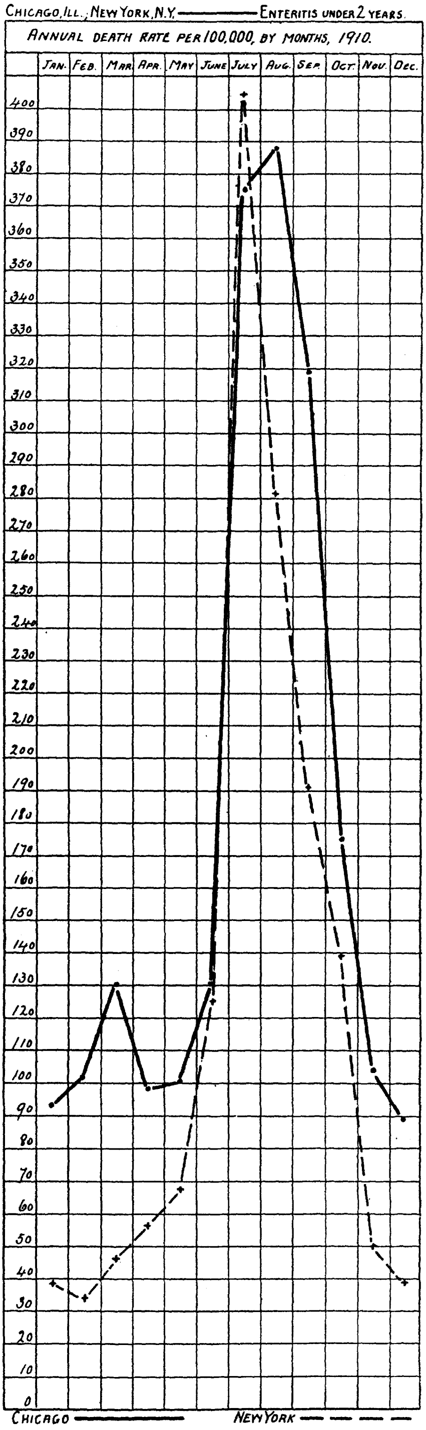

Chart No. 12.

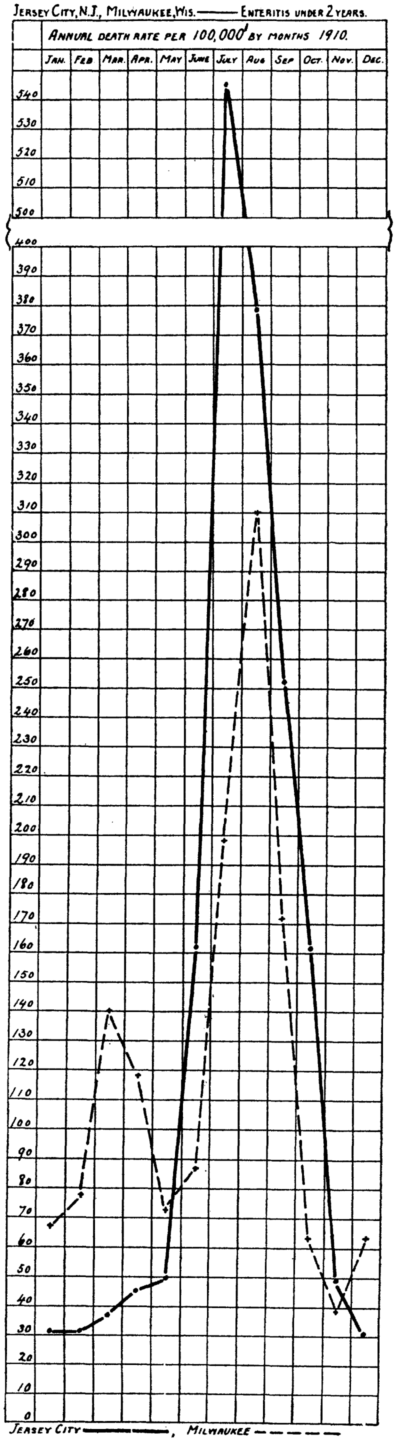

Chart No. 13.

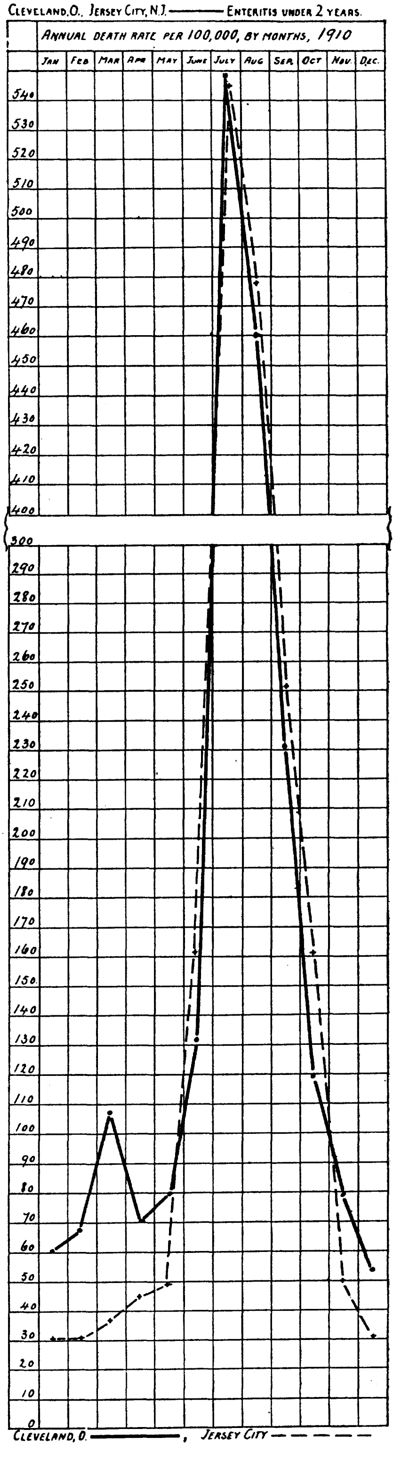

Chart No. 14.

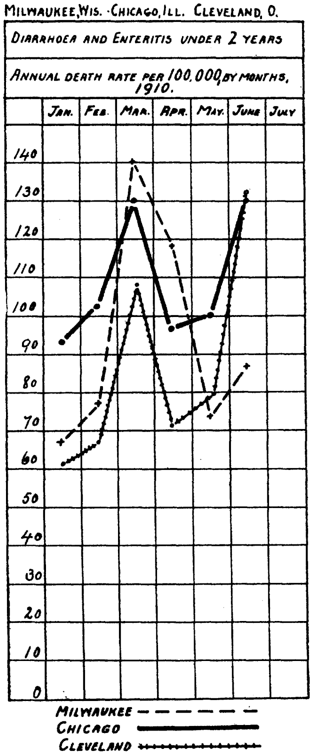

Chart No. 15.

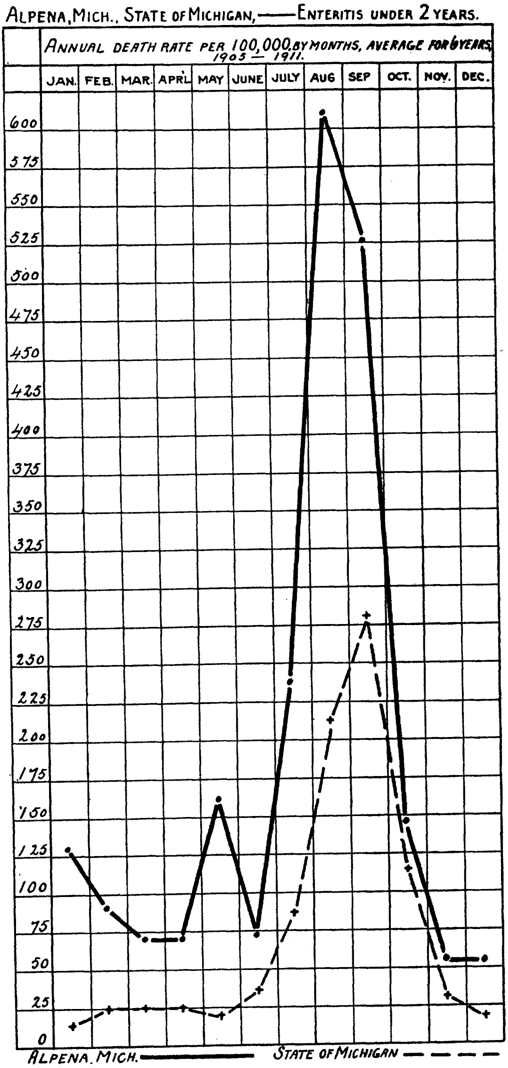

Chart No. 16.

The following table shows the reductions which occurred in the general death rate, the typhoid rate, and the enteritis rate in 1910, following the use of filtered water.

TABLE No. 15.—*Escanaba, Mich.*

Year.	Death rate per 1,000 inhabitants.	Total deaths.	Typhoid-fever deaths.	Enteritis under 2 years; deaths January to June.
1908........	18	228	12	7
1909........	16.8	213	28	7
1910........	15.5	206	8	1

THE RELATION OF TYPHOID FEVER TO DIARRHEA AND ENTERITIS.

There is a close relation between the curves for typhoid fever and diarrhea and enteritis in many cities, especially in the winter and spring months. This relation is usually disturbed by the sudden rise of the enteritis curve in June or July while the typhoid rise is usually a month later, and not so high.

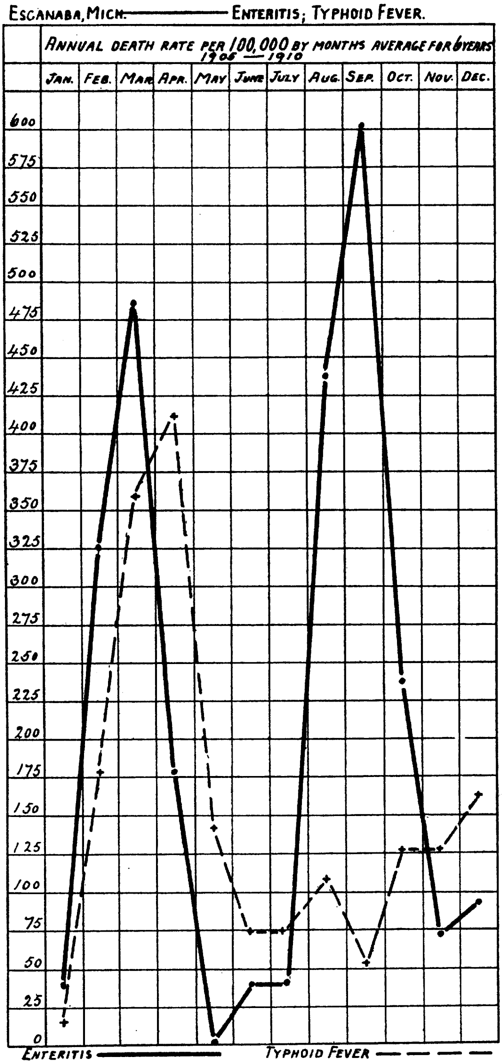

Chart No. 17.

Chart No. 17 shows the relation between the curves for enteritis and typhoid fever by months in Escanaba, Mich., taking an average for six years. Note the abnormally high peaks for both diseases in the spring months and that the spring speak for typhoid is one month later than the pronounced enteritis peak in March. Chart No. 18 shows the curves for typhoid and enteritis compared in Washington,

D. C. Washington has a safe water supply and the rates from January to June for both enteritis and typhoid are low. The close relation between the two curves is apparent.

Chart No. 19 shows the same comparison made in Battle Creek, Mich. Battle Creek's water supply is not above suspicion. Enteritis and typhoid fever show synchronous peaks in the curve in January and March.

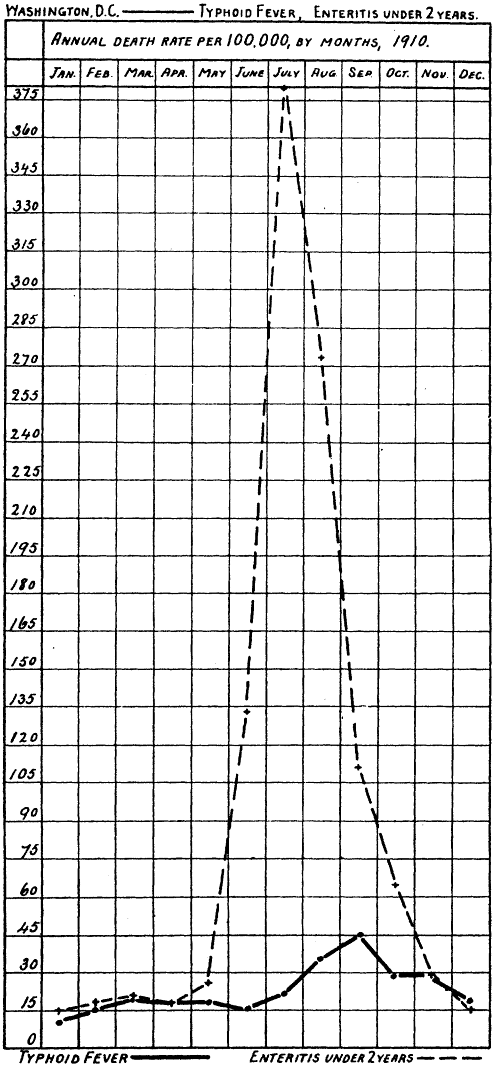

Chart No. 18.

Pittsburgh in 1910 had a high typhoid-fever rate in the months from January to June. It also had an abnormally high enteritis rate for the same period and a very pronounced peak in March. This relation is shown in chart No. 20.

Milwaukee in 1910 had an unusually high typhoid-fever rate from January to June. The enteritis rate was also very high considering the season, with a pronounced peak in March. Chart No. 21 shows the typhoid and enteritis curves compared in Milwaukee.

Chart No. 22 shows the relation between these curves in Cleveland. The winter and spring typhoid in Cleveland shows a peak in April. The enteritis curve shows a marked rise one month earlier, in March.

Cohoes is another example of very high rates for both typhoid and enteritis in the winter and spring. Chart No. 23 shows the relation between the curves. In addition to the high rates in January, February, March, and April the coincident rise in both curves in December is notable.

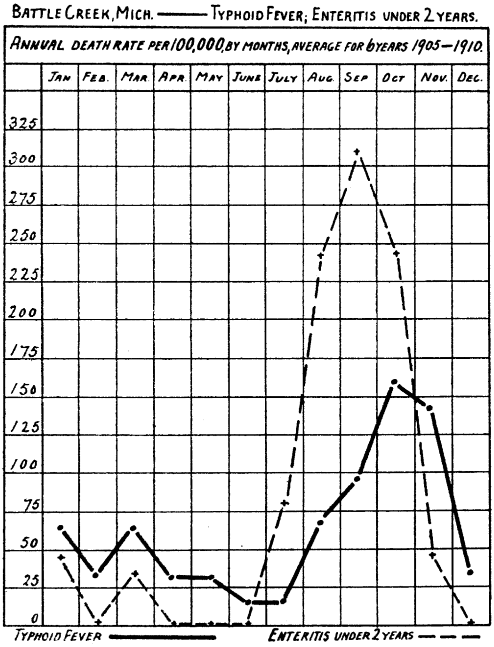

Chart No. 19.

Chart No. 24 shows the curves for typhoid fever and enteritis compared in Niagara Falls. The winter peak for typhoid is pronounced and one month later than the peak for enteritis. On the other hand the rise in May is synchronous and the two curves drop almost together in June.

The relation between enteritis in children and typhoid fever can not be said to be clear. Certain facts, however, stand out prominently in studying the statistics. In cities which are too small to have slums and which have abnormally high typhoid-fever rates there is also an excessive mortality from enteritis and diarrhea in children under 2 years of age. Cities of the same class with low typhoid rates have comparatively low rates for enteritis and diarrhea of children.

The seasonal prevalence also closely follows that of typhoid. If the excessive typhoid in these cities is due to water then we have a high enteritis rate, not only in the summer and autumn, but also in the winter and spring months. If the typhoid is independent of the water supply, then the enteritis rate like that of typhoid, will be high in the regular season from July to October and low during the remainder of the year.

The effect of polluted water upon young infants may be indirect as well as direct. The polluted water may be used to dilute milk, to wash milk bottles, or directly as a beverage. Further, the polluted water supply, which causes numerous typhoid cases in cities or towns, is responsible indirectly for the contact infections in children resulting from such cases. That many of these occur in children can scarcely be doubted, even if they remain undiagnosed as typhoid and enter the statistics as diarrhea or enteritis.

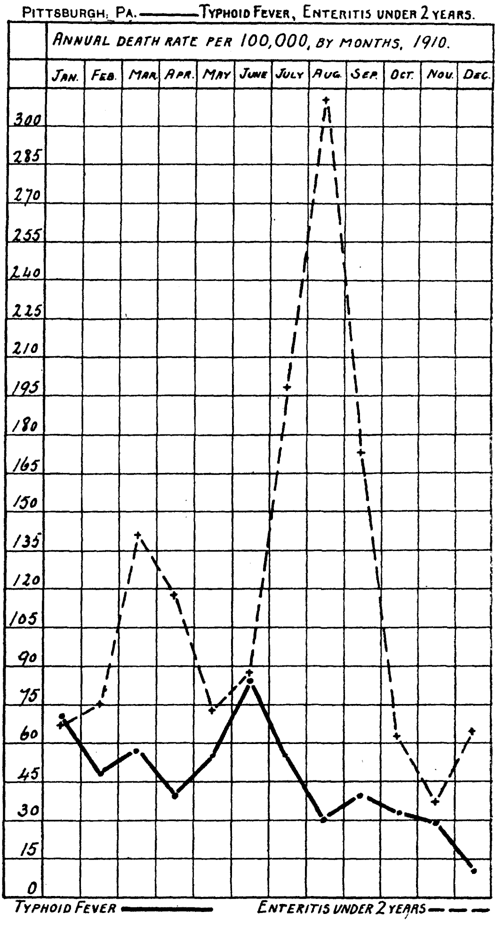

Chart No. 20.

The idea that typhoid fever is not a disease of childhood lacks satisfactory evidence to support it. The mere fact that the bulk of the reported cases is made up of adults is not proof. The writer's experience with cholera,[1] an analogous disease epidemiologically, suggests that typhoid, like cholera, may be much more frequent in children than popularly supposed, and that a tendency to light or atypical symptoms in children may be expected.

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[1] McLaughlin, Allan J., "Some observations upon cholera in children," Philippine Journal of Science, sec. B, 1909, vol. 4, p. 363.

Mere parallelism does not indicate identity of causation. It indicates rather similar modes of transmission and, possibly, identity in a portion of the cases.

Often the unusual prevalence in winter and spring, instead of showing parallelism between the curves, shows that the typhoid peak is one month later than the peak for enteritis. This same peculiarity is noticeable in the outbreaks of the so-called "winter cholera." After a gross pollution of the water supply by sewage, there follows a sudden massive outbreak of "winter cholera."

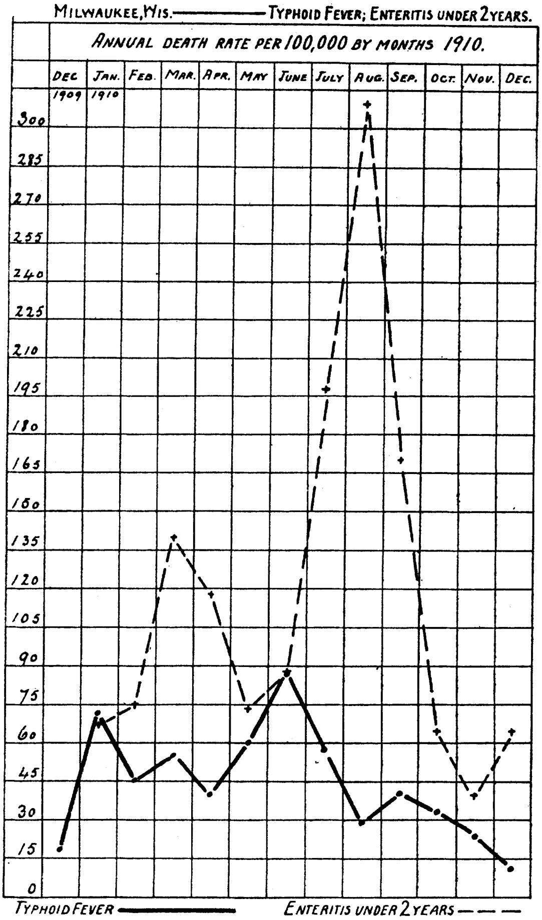

Chart No. 21.

This is usually followed about one month later by a typhoid outbreak. The exact causation of winter cholera is obscure. It has nothing to do with season, however, and one of the best examples of this disease occurred at Mackinac Island in August. Whatever the real relation between typhoid fever and enteritis or diarrhea of children may be, one fact is clear, that the same causes operate to cause

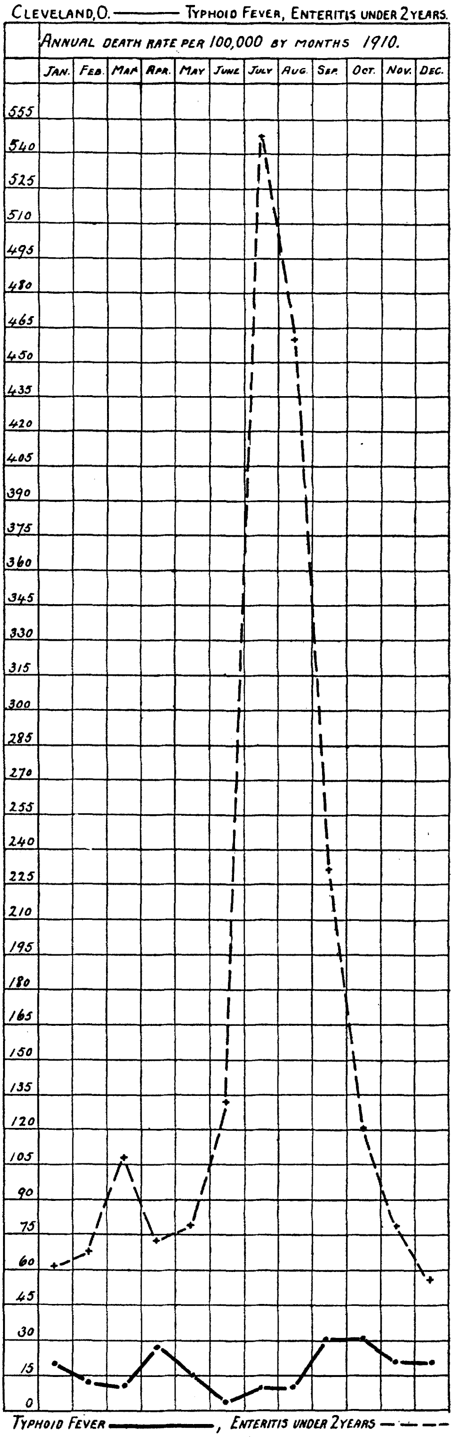
CLEVELAND, O. —— TYPHOID FEVER, ENTERITIS UNDER 2 YEARS.
ANNUAL DEATH RATE PER 100,000 BY MONTHS 1910.
JAN.
FEB.
MAR.
APR.
MAY
JUNE
JULY
AUG.
SEP.
OCT.
NOV.
DEC.
555
540
525
510
495
480
465
450
435
420
405
390
375
360
345
330
315
300
285
270
255
240
225
210
195
180
165
150
135
120
105
90
75
60
45
30
15
0
TYPHOID FEVER ——, ENTERITIS UNDER 2 YEARS — — —

Chart No. 22.

excessive prevalence in both. It is probable that cases of typhoid in children under 2 years in many cities are often diagnosed as enteritis. It must be remembered, however, that the causative agent of bacillary dysentery is transmitted in the same way and by the same media as that of typhoid. There are too many cases of fatal illness in children under 2 years classed as diarrhea and enteritis, and an exhaustive investigation should be made to establish the real cause of death in enteritis and diarrhea of children. Without such an investigation it is impossible to assign the real cause of the excessive child mortality from diarrhea and enteritis. In cities of less than 50,000 population without slums and which are not "mill" towns an enteritis rate in children under 2 years above 100 deaths per 100,000 indicates prevalence of an acute intestinal disease preventable by the same measures

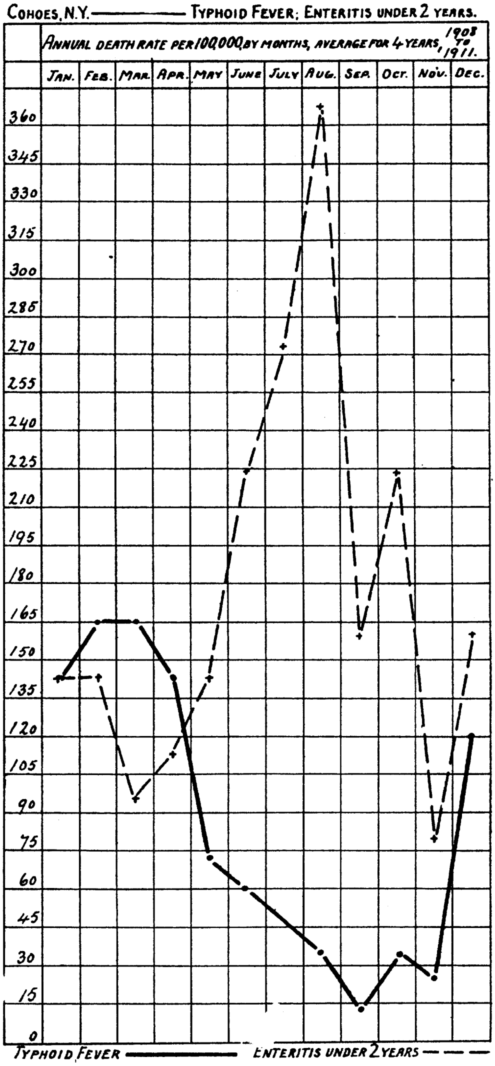

Chart No. 23.

which prevent typhoid fever. It is probable that in such cities proper enforcement of prophylactic measures against typhoid fever would reduce the enteritis rate below 40 deaths per 100,000. Enforcement of prophylactic measures would include the installation of pure water supplies and proper sewerage systems, coupled with a vigorous campaign against the insanitary outdoor privy and the dangerous shallow well.

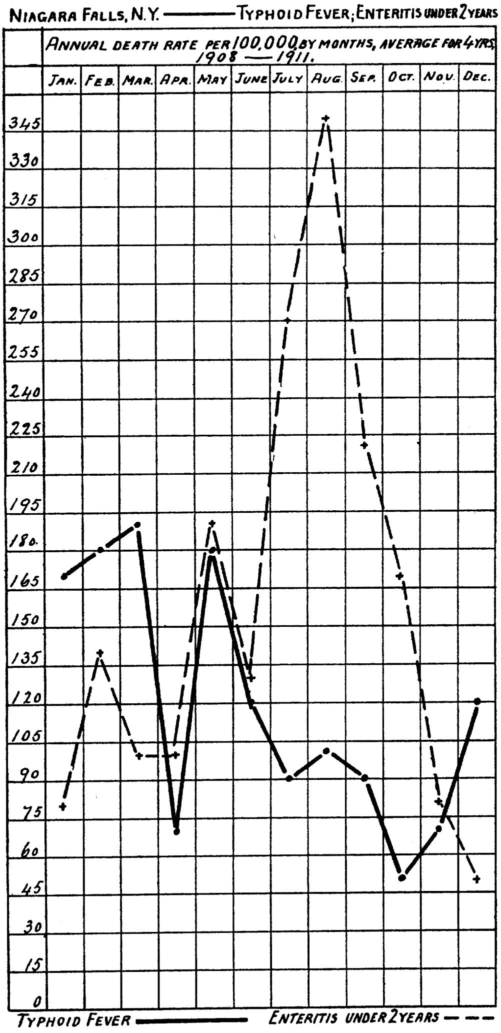

Chart No. 24.

CONCLUSIONS.

1. From a study of a considerable number of cities it seems probable that the reduction in the general death rate which has been called the Mills-Reincke phenomenon, when present, is due in greatest measure to the reduction in those diseases which are grouped under the heading of diarrhea and enteritis of children.

2. The Mills-Reincke phenomenon and Hazen's theorem are not always apparent after betterment of the public water supply because

of wide fluctuations in the death rates for contagious diseases which are not water borne.

3. Because of the reducing influence on death rates of the campaign against tuberculosis, the improvement in control of milk supplies, the use of diphtheria antitoxin, education of the public in personal hygiene, and the prevention of disease it is difficult to say in some instances to what extent an improved water supply is a factor in the reduction of the general death rate.

It is certain, however, that in practically every instance, in addition to a lessened number of deaths from typhoid fever, the substitution of a safe for a polluted public water supply results in the saving of many lives from diseases which are not reported as typhoid fever.

The question of the identity of these diseases can be answered only after an exhaustive investigation of deaths, and especially of that group of entities which is now reported under the heading of "Diarrhea and enteritis under 2 years."

4. Enteritis or diarrhea in children as a fatal disease may be expected to be excessively prevalent in large cities with slum districts and a large foreign population. The same excessive prevalence may be expected in so-called mill towns, where the mothers are operators in the mills and child neglect is common. Under these conditions the mortality among poor children is very great, but it is almost entirely in the period from July to October, provided the public water supply is safe.

5. In cities with safe water supplies and enteritis rates above the average for the State the ratio of summer and autumn to winter and spring enteritis should be at least 4 to 1, taking the months of June, July, August, September, October, and November for the summer and autumn enteritis, and the months of December, January, February, March, April, and May for the winter and spring enteritis.

6. Cities with grossly polluted water supplies often have a winter and spring enteritis which is more than one-fourth of the summer and autumn enteritis. If such a phenomenon is present each year for several years, it suggests that the polluted water supply is a factor in the enteritis mortality in winter and spring.

7. The relation between typhoid fever and the diarrhea and enteritis of children is not clear. There is often a striking parallelism in seasonal prevalence between the curves, but mere parallelism does not necessarily indicate identity. It may and usually does mean similarity in modes of transmission. Often in the winter and spring months there is a sharp rise in both diseases, the typhoid peak being one month later than that of diarrhea and enteritis.

Cities without slums and with good sanitary conditions except grossly polluted water supplies have excessively high rates for both typhoid fever and diarrhea and enteritis in the winter and spring months. Cities with good water supplies and low typhoid-fever rates may have high rates for diarrhea and enteritis under 2 years, but the rates in winter and spring will be relatively low.

8. Closer cooperation between the practicing physician and the local health departments is necessary in order to carry out an investigation of the true nature of the diarrhea and enteritis in children under 2 years, now classified as diarrhea and enteritis.

9. There should be a wider employment of municipal laboratories by practicing physicians, especially in the diagnosis of typhoid fever and examination of the discharges of sick children.